1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

2

The theory of activation of carbon. G. L. Chuvarov. *J. Russ. Phys.-Chem. Soc.* 62, 883-95(1930).—C residue of high purity (99.7-99.8% C) was prepd. by decompg. piperonal in an autoclave at 200-210° and 18-20 atm. pressure. The adsorbing power of this C for CO_2 was very high and varied with the preliminary heating (with max. at 1000° heating temp.), but was not affected by activation. Adsorption of phenol from soln. was insignificant for unactivated, and very high for activated C. Preliminary heating of primary C residue above 500° greatly lowers its activity toward phenol. Distinction is drawn between adsorption of gases (and colloidal particles), which is of a phys. character, and adsorption from true solns., which has a chem. character. The difference is explained, in accordance with Ruff (*C. A.* 21, 1734), by the formation during heating of a surface film closing up the amorphous C atoms; this film is removable by activation. This explanation is supported by detn. of sp. gravities of activated and unactivated C previously heated to various temps. B. N. Daniloff

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

3RD AND 4TH ORDERS

PROCESSES AND PROPERTIES INDEX

Ca

22

Desulfurization of Chusovskie Gorodki petroleum distillates with silica gel. G. I. Chuzarov and M. R. Litovchenko. *J. Chem. Ind.* (Moscow) 8, 65-8(1931).—Silica gel removes only mercaptans from petroleum distillates; by a combination of treatment with H_2SO_4 and with this adsorbent 70% of the S can be removed. B. C. A.

ASB-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

A

18

Potash by the magnesium method. G. I. Chufarov and V. S. Knutarev. *J. Chem. Ind.* (Moscow) 8, 232-8(1931).—The manuf. of potash by the Mg method takes place in three stages: (1) formation of cryst. $MgCO_3.3H_2O$ from $MgO + CO_2$; (2) formation of the double salt: $3(MgCO_3.3H_2O) + 2KCl + CO_2 \longrightarrow 2(MgCO_3.KHCO_3.4H_2O) + MgCl_2$; (3) decompn. of this salt with sepn. of potash. Only $MgCO_3.3H_2O$ is suitable. It is obtained by hydrating 40 g. of MgO in 300 cc. of boiling H_2O. When the soln. is cool, 700 cc. of $Mg(HCO_3)_2$, obtained from the preceding prepn. of trihydrate, is added and immediately treated with gas contg. 20-25% of CO_2 at 2-4 atm. The soln. must be stirred and the temp. kept at about 20°. After carbonization is complete, 700 cc. of the soln. is removed and the residue contains 40 g. of MgO as $MgCO_3.3H_2O$ + 300 cc. of H_2O. Then 50 g. of KCl is added to this residue, with stirring. The gas contg. 20-25% CO_2 and having the min. partial pressure of 1 atm. is introduced. The temp. must be 17-24°. Decompn. of the double salt was accomplished (a) in an autoclave at 115-140°: $2(MgCO_3.KHCO_3.4H_2O) = 2MgCO_3 + K_2CO_3 + 9H_2O + CO_2$, the salt being in a beaker and moistened with H_2O. $MgCO_3$ is anhyd. and is not changed into trihydrate even by the H_2O soln. of CO_2. By this method 200 g. of potash is obtained per l. $MgCO_3$ is easily filtered off, changed into MgO by ignition and then carbonized; (b) decompn. with H_2O in closed vessel at 50-80°: $MgCO_3.KHCO_3.4H_2O \rightleftharpoons KHCO_3 + MgCO_3.3H_2O + H_2O$, formation of $KHCO_3$ depending upon the temp. and its concn. being low. $MgCO_3$ is mostly amorphous and not suitable for the prepn. of the double salt; (c) decompn. by heating at 150-180° to const. weight. The potash was dissolved in H_2O on a bath. $MgCO_3$ is anhyd., is easily filtered off and changed into MgO by ignition; (d) decompn. with $Mg(OH)_2$: $2(MgCO_3.KHCO_3.4H_2O) + MgO = 3(MgCO_3.3H_2O) + K_2CO_3$. With this method a high concn. of potash is necessary. When the H_2O content is lower than a certain limit, $MgCO_3$ forms small crystals, the substance is thick and the decompn. is incomplete. The amt. of potash should not exceed 65-70 g. per l. It was proved that with the greater concn. of potash the decompn. of the double salt proceeds more slowly, and $MgCO_3.K_2CO_3.4H_2O$ may be formed.

V. D. Karpenko

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

CA

18

Hydrolysis of magnesium chloride. G. I. Chufarov and A. P. Lohvitskaya. *Kalii* (U. S. S. R.) 1933, No. 8, 24-8.—To develop a method for prepn. of MgO and HCl from $MgCl_2.6H_2O$ and reduce the steam consumption required by the process formerly reported, a no. of expts. were performed, which show that drying of $MgCl_2.6H_2O$ in 2 stages, 80-110°, and 110-150°, under atm. pressure produced a porous salt of the following approx. compn.: $MgCl_2$ 67-71, MgO 1-6, H_2O 32-30%. This salt easily hydrolyzed in 15 min. with steam at 600°; 0.7 part by wt. of steam was consumed to 1 part MgO formed. Yields of 15 g. MgO (contg. less than 1% Cl_2) and 30-35% HCl were obtained from 100 g. $MgCl_2$. Steam consumption was reduced 16 times by raising the hydrolysis temp. from 450° to 600°.

James Sorrel

COMMON ELEMENTS

MATERIALS INDEX

COMMON VARIABLES INDEX

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

CA

2

Velocity of reaction in systems consisting of two liquid phases. G. I. Chufarov and N. N. Agafonov. *J. Phys. Chem.* (U.S.S.R.) 5, 930-35(1934).—The velocity of the I-hyposulfite reaction was studied in systems composed of 2 liquid phases by using a mech. stirrer system turning at a const. speed and a thermostat at 25 ± 0.02°. CCl_4-H_2O, $CHCl_3$-H_2O and CS_2-H_2O systems were studied with the I dissolved in the first component and $Na_2S_2O_3$ in the water. The reaction is of pseudounimol. order. The velocity const. for various systems depends upon the velocity of diffusion of the I in the nonaq. phase, $K = (2.303/t) \log ([S_2O_3^{--}]_0 + n)/([S_2O_3^{--}] + n)$, in which n is directly proportional to the concn. of I in the nonaq. phase and inversely to the distribution coeff. Surface-active substances such as stearic or phenylacetic acids do not affect the reaction proceeding on the phase boundary. Addn. of NaI accelerates the reaction by changing the distribution coeff. for the I for which data are given for the above systems with the addn. of up to 0.0[illegible] N NaI. F. H. Rathmann

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS — 3RD AND 4TH ORDERS

PROCESSES AND PROPERTIES INDEX

CP

2

Effect of a porous silica gel catalyst carrier on the velocity of oxidation of sulfur dioxide gas. I. G. I. Chuf[illegible], N. N. Agafonov, K. P. Tatievskaya and K. I. Kulpi[illegible]. *J. Phys. Chem.* (U. S. S. R.) 5, 936–45(1934).—In a table are given the values of the percentage yield of SO_3 as a function of the porosity of the gel for 10 different platinized gels with porosities from 118 to 10 and at 10 temps. from 300° to 500°. At porosities above about 50 the differences in yield are small, but below 50 the yield falls rapidly from 98 to 43% at 410° but less so at higher temps. Porosity above 100 again slightly decreases the yield. The activation energy is 18,000 cal./mole. Measurements of the pore dimensions by means of C_6H_6 indicate an ultraporous structure with diams. of less than 4×10^{-7} cm.

F. H. Rathmann

ASA-SLA METALLURGICAL LITERATURE CLASSIFICATION

MATERIALS INDEX — AUTHOR INDEX

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

CA

Reduction of iron oxides by gaseous reducing agents. Velocity of reduction of ferric oxide by hydrogen. G. I. Chufarov and A. P. Lokhvitskaya. *J. Phys. Chem.* (U. S. S. R.) 5, 1103-13(1934).—The app. is described. rtificial and natural Fe_2O_3 contg. 98.6% Fe_2O_3, 0.35% O_3 and 1.1% SiO_2 were used. For both, an auto-talytic character of the speed of reduction by H was vealed sharply. The first stage, reduction to magne-te, is not autocatalytic. The remaining stages, belong-g to the type of intersurface reactions, proceed auto-talytically. The anomalous course of the reduction urve above 800° is due to changes in the micro- and ultra-icroporosity of the solid product. The rates of reduction t temps. from 300° to 900° are shown by a series of 11 raphs for various conditions of particle size, degree of revious reduction, etc. The porosity of the product is reater the lower the reduction temp. E. H.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

CA

2

Reaction zones in the reduction of magnetite and hematite with hydrogen. G. I. Chufarov and E. P. Tatievskaya. *Acta Physicochim. U. R. S. S.* 3, 957-74(1935); cf. *C. A.* 30, 29.—The reaction is autocatalytic. The change in porosity with temp. and degree of reduction was studied and related to the reaction rate. Magnetite is less porous than hematite, but below 600° the rate of reduction is faster. Above this temp. the porosity and the rate of reduction decrease rapidly in both cases. Microscopical investigations show the presence of the layers α-Fe-Fe_3O_4 in the case of magnetite and α-Fe-Fe_3O_4-Fe_2O_3 in the case of hematite, while FeO could not be detected, and it is suggested that $Fe_3O_4 \rightarrow Fe$ is the rate-detg. process. The rate of advance of the reduction zone is linear below 500° and the activation energy for hematite is 15,700 g.-cal. B. C. A.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

PROCESSES AND PROPERTIES INDEX

CA

2

ent of the porosity of silica gel as a catalyst carrier the velocity of oxidation of sulfur dioxide gas. G. I. ofeev, E. P. Tatievskaya and K. I. Kul'pina. J. n. Chem. (U. S. S. R.) 6, 152-6(1935).—V_2O_5 on SiO_2 served as catalyst. Changes in the porosity of the alyst up to 70% were made. At low temps. the effect porosity on yield is greatest. At 480° the yield is st a linear function of porosity. At 520°, the effect less. With increasing porosity the temp. of the max. ld of SO_3 is lowered. Reaction velocities given in the les change with the value of the "working surface." tivation energies are the same for catalysts of various rosities but increase from 21,500 at 430-50° to 40,000 lower temp. (360°). Zelikov

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

PROCESSES AND PROPERTIES INDEX

Influence of the crystalline lattice of an oxide upon the speed of reduction with hydrogen. G. I. Chufarov and G. F. Vilesova. *Teoriya i Prakt. Met.* No. 6, 10-17 (1936).—Expts. were performed with grains of 0.5-1.0 mm. and with cubes of 5 × 5 × 5 mm. prepd. from natural crystals of hematite and magnetite. Artificial oxides were prepd. from piano wire. Reduction with H was conducted at all possible temps. up to 800-900°. Above 600° the ultra- and micro-porosity of the magnetite reduction products is small. This blocks the penetration of the gas and the reduction is hindered. But below 600° the magnetite is sometimes reduced faster than the hematite. At higher temps. the small cryst. structure favors reduction, but at low temps. it may hinder it because of its great adsorption of the reduction products. B. Z. K.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

RA

2

Effect of form of intermediate phases on the velocity of the reduction of iron oxide by hydrogen. G. Chufarov and B. Averbukh. *Acta Physicochim. U. R. S. S.* 4, 617-35([illegible]); cf. *C. A.* 30, 8115[6].—The velocity of reaction of natural cryst. magnetite and hematite with H_2 was measured at intervals of 20° from 300° to 700°. The change in porosity during reduction was followed and the structure at different stages of the reaction investigated by x-ray analysis. The reaction appears to be autocatalytic. Fe_3O_4 is present at all stages of incomplete reduction. FeO is not observed. From 300° to 500° the porosity is independent of *T* and detd. by the degree of reduction. Above 500° the porosity decreases rapidly with *T*, while the size of the crystals of α-Fe increases. The temp. coeff. of the reaction is normal up to 550° and low above this temp. The activation energy is calcd. to be 16,500 g.-cal. for magnetite and 19,500 g.-cal. for hematite below 550°.

B. C. A.

ASB-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

3RD AND 4TH ORDERS

PROCESSES AND PROPERTIES INDEX

CA

2

Effect of water vapor on the rate of reduction of magnetite and hematite by hydrogen. K. P. Tatievskaya and G. I. Chufarov. *J. Phys. Chem.* (U. S. S. R.) 10, 747-50 (1937).—Exptl. data on the effect of added water vapor on the rate of reduction of naturally occurring magnetite or hematite and other iron ores for temps. from 400° to 900° are summarized in 13 graphs. From 400° to 800°, addn. of about 15% H_2O practically stops reaction on the boundary Fe_3O_4/Fe_2O_3 because of almost complete surface covering resulting from the strong adsorption of H_2O on the Fe_3O_4 surface obtained. Near 800° adsorption is less and H_2O vapor shows no hindering effect. For the reduction of Fe_3O_4 on the boundaries Fe_3O_4/α-Fe and Fe_3O_4/FeO H_2O vapor has a somewhat lesser hindering effect, and this effect can be quantitatively calcd. on the basis of the adsorptive capacities of H_2 and H_2O gases on the resp. surface interfaces. F. H. Rathmann

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

1a

2

The reaction velocity of carbonyl sulfide with sulfur dioxide in the presence of various catalysts. G. I. Chufarov and V. S. Udintseva. *J. Applied Chem.* (U.S.S.R.) 10, 1199-1210(in English 1210)(1937).—The reaction of COS with SO_2 was investigated at 600-800° in the presence of Fe, Al and Ti oxides (14 catalysts) on pumice and porcelain carriers. The reaction proceeds with a considerable velocity only under pressure of reacting gases exceeding a certain minimal "critical" pressure. The change of reaction velocity is sharp when the pressure near the "critical" pressure is slightly reduced. The magnitude of the "critical" pressure depends on the presence of the particular catalyst and on the method of its prepn. The highest pressure was observed in carrying out the reaction in a quartz tube without any catalyst, and the lowest pressure in the presence of Fe catalyst prepd. by a reduction of Fe_2O_3 to Fe at low temp., and Ti catalyst. The reaction proceeds almost to completion in the presence of Fe and Ti catalysts, but even in these cases the reaction does not reach an equil. The reaction ceases when the gas phase contains COS about 0.6 and SO_2 0.3%. Raising the temp. of the reaction from 600° to 800° or using an excess of SO_2 (up to 45%) instead of an equiv. has no essential effect on the completeness of the conversion of COS. A chain mechanism of the reaction with "degenerated branchings" of the chains is proposed to explain the exptl. data. Ten references. A. A. Podgorny

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

S

4

Catalysts for Bell's Reaction ($2CO \rightarrow CO_2 + C$). G. I. Chufarov and A. N. Kulikov. (Metallurgist, Russia, 1937, vol. 12, No. 3, Mar., pp. 3-7). (In Russian). The authors investigated the catalytic decomposition of carbon monoxide by iron prepared from ferric oxide by reduction in hydrogen at 300° C. and by ferrous oxide prepared by oxidising metallic iron with water vapour and hydrogen at 900° C. The variations in the pressure of a constant volume of carbon monoxide circulated over the catalysts at 400-500° C. were determined. Ferrous oxide has not been found to promote the decomposition of carbon monoxide, but iron has a strong effect, until its surface becomes covered with ferroso-ferric oxide produced by the oxidising action of carbon dioxide, when the reaction ceases.

ASD-SLA METALLURGICAL LITERATURE CLASSIFICATION

CHUFAROV GRIGORIY IVANOVICH

10

The Kinetics of Decarburisation of Transformer Steel on Annealing in Hydrogen. B. D. Averbukh and G. I. Chufarov. (Metallurg, 1939, No. 7, pp. 48-61). (In Russian). A review of earlier work is given by way of introduction. The authors' experiments were carried out with 0·5 and 0·35 mm.-thick specimens of sheets of transformer steel containing silicon 4% and carbon 0·06%. The apparatus used is described. The methane formed was burnt and the carbon dioxide, water and hydrogen sulphide were condensed and determined manometrically. Data obtained for the rate of decarburisation at 600°, 800° and 1000° C. are shown in diagrams. Further experiments showed that the addition of water vapour to the hydrogen slows down the decarburisation considerably owing to the formation of a film of silica or iron silicate which prevents the hydrogen reaching the surface of the metal. The addition of nitrogen also slowed down decarburisation, this being due to the reduction of the partial pressure of the hydrogen. A theoretical discussion of the experimental results leads the authors to the conclusion that decarburisation proceeds by the carbon diffusing to the surface and there reacting with the hydrogen, the rate of decarburisation being controlled by the rate of reaction between the carbon and hydrogen to form methane, and not by the rate of diffusion of the carbon to

over

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

the surface. For industrial application a temperature of 1000° C. or higher and a rapid stream of hydrogen to remove the methane formed are necessary. Some form of "regeneration" of the hydrogen (removal of methane and other impurities) would be required. Decarburisation with mill-scale is about five times more rapid than with hydrogen, the carbon reacting much more rapidly with the oxygen of the scale than with hydrogen, the latter merely acting as a protective atmosphere.

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

CA

9

Effect of carbon dioxide on the velocity of reduction of magnetite and hematite by carbon monoxide. E. P. Tatievskaya and G. I. Chufarov. *J. Phys. Chem. (U. S. S. R.)* 13, 493-501 (1939).—Exptl. data over the temp. range 400-900° and at gas pressures of 0.02 to 0.20 mm. Hg are given. The retarding effect of CO_2 on the initial stage of reduction of magnetite is considerable at 500° and negligible at 900°; CO_2 does not affect the initial reduction of hematite, but after a Fe_3O_4 surface layer has once formed, hematite behaves the same as magnetite.

F. H. Rathmann

Ural Phys.-Tech. Inst., Sverdlovsk

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

BUYNOV, N., ZHURAVLEVA, M., KOMAR.,A., CHUFAREV, G.

Orientation of Iron Crystals on "agnetite during the Reduction of Magnetite with Hydrogen. DAN SSSR 22, 27, 1939.

Ural Phys. Tech. Inst., Sverdlovsk

11A

"Black Spots" on Zinc-Coated Iron. G. I. Chufarov and A. V. Shchepanova (*Ural. Met.*, 1940, (2), 15-17; *Khim. Referat. Zhur.*, 1940, (9), 118; *C. Abs.*, 1943, 37, 858).—[In Russian.] Deep "black spots" are found on the surface of sheet iron where zinc coating has failed to take effect; surface "black spots" are distributed on the zinc film. Surface spots are attributed to adhesion of flux residue; the flux ($ZnCl_2$) is oxidized to $ZnOHCl$ and Zn_2OCl_2. The deep spots are the result of the non-wettability of some parts of the iron sheet by zinc. These places are usually covered with an oxide film or with unfused flux. To prevent "black spots" it is proposed to add 125-150 grm. of NH_4Cl per litre to the flux. NH_4Cl facilitates the cleaning of the iron sheet before zinc-coating, by forming $FeCl_3$ (which dissolves easily in the flux) with any iron oxides present. Data obtained with the new flux under plant conditions are given.

1942

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

cA

7

Determination of small amounts of carbon in steel. M. O. Zhuravleva and G. I. Chufarov. *Zavodskaya Lab.* 9, 498-9(1940).—The Jensen method for detg. C in steel from the pressure of the CO_2 is modified to make it applicable to steels contg. S. The steel sample is burned in a stream of O_2 at 1200° and the SO_2 and CO_2 are frozen in a trap at the temp. of liquid air. The gases are then vaporized in a small but definite vol. and their total pressure is detd. The gases are then again frozen at the temp. of liquid air after which the temp. is raised to −132° at which the pressure of SO_2 is negligible and that of the CO_2 is 2 mm. Hg. The trap is then dipped in liquid O so as to cause the CO_2 to condense therein. After 10 min. the gases become completely sepd. The SO_2 is then vaporized alone and its pressure is detd. The pressure of the CO_2 is detd. by difference. The accuracy of the C detn. is 0.0002%. Diagram of the app. is shown B. Z. Kamich

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

PROCESSES AND PROPERTIES INDEX

CA

2

The kinetics of the reaction of sulfur dioxide with hydrogen sulfide. V. S. Ushintsev and G. L. Chudarev. J. Chem. Ind. (U. S. S. R.) 17, No. 3, 34-8(1940).—At 250-300° the reaction is unimol. and has an activation energy of about 10,000 cal./mole. It takes place entirely on the walls of the vessel and goes best on glass. When the vessel surface is covered with Al or Al_2O_3, the reaction is nearly as rapid as on glass, but when the surface is Fe the reaction rate is slow, and when it is Fe_3O_4 or Cu, the reaction almost stops. In glass at 380° an equiv. mixt. of H_2S and SO_2 takes 5-6 hrs. to react, depending on the shape of the container. H. M. Leicester

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

CA

"Hydrogen embrittlement" of steel. G. I. Chufarov and S. S. Nosyreva. *Stal* 1941, No. 5, 61-3; *Chem. Zentr.* 1942, II, 1811-12.—After pickling, steel billets or annealed steel should be heated to 100-200° for 30-60 min. or left at room temp. 30 days before cold rolling to eliminate absorbed H_2 and restore the plasticity.

H. W. Rathmann

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

3RD AND 4TH ORDERS

PROCESSES AND PROPERTIES INDEX

C4

7

Determination of hydrogen in steel. S. S. Nosyre and G. I. Chufarov. *Zavodskaya Lab.* 11, 1047-50 (1945).—A modification of the Newell app. for detg. H_2 in steel is described. The app. consists of a heating tube made of transparent quartz connected to the app., a MacCleod manometer, 2 Langmuir Hg pumps, a manometer with small calibrated bulbs connected to the Hg pump, and traps with activated charcoal placed between the heating tube and the MacCleod manometer. Place the sample in the heating tube, open the stopcocks, pump out the air by means of an oil pump and the Langmuir Hg pump, close the stopcocks after the desired vacuum has been reached, immerse the trap with activated charcoal into a Dewar flask with liquid N_2 or O_2, place the heating tube in an oven heated to 800°, and ext. the H_2 from the steel. The H_2 evolved from the steel is forced through the trap with activated charcoal by means of a 2nd Langmuir pump, and is collected in the large bulb of the combination manometer. The quantity of H_2 evolved can be measured at any time after the beginning of the expt. by forcing the H_2 from the large bulb of the manometer into 3 small bulbs and raising repeatedly a column of Hg until no pressure readings on the manometer scale are obtained. The vol. of the H_2 evolved is detd. by the vol. of the 3 small bulbs (3, 14, and 35 ml., resp.). At 800° the H_2 is evolved from steel first rapidly, then more slowly after 15-20 min., and, finally, no H_2 is evolved after 1-2 hrs. All gas collected in the bulbs is pure H_2 because all impurities are absorbed by activated charcoal at 180°. One reference. W. R. Henn

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

CHUFAROV, G. I.

"Obtaining Cast Iron, Iron and Steel by theReduction of Carbonized Ore," Iz. Ak. Nauk SSSR, Otd. tekh. nauk, 1946, No. 6.

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

OA

9

Metal phosphatizing solution. S. S. Nosyreva and G. I. Chufarov. U.S.S.R. 67,700, Dec. 31, 1940. To a metal phosphatizing soln. is added $ZnCl_2$ which reduces the quantity of slime formed in the bath and causes the deposit on the metal to be cryst. and dense. M. Hosch

COMMON ELEMENTS

COMMON VARIABLES INDEX

MATERIALS INDEX

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

20

9

Production of cast iron, iron, and steel by reduction of carbon-impregnated ores. Chufarov. *Bull. acad. sci. U.R.S.S., Classe sci. tech.* 1946, 883-90.—Reduction of an iron ore mixed with C black was complete in 2 min. at 1500°, 5 min. at 1200°, and 10-15 min. at 1000°; the same ore mixed with charcoal only attained 30% reduction in 3 min. at 1200°, about 37% in 10 min. A process was developed whereby the ore is first enriched with C through treatment with producer gas at 500° which results in 20-25% reduction and impregnation of the ore with C black; the C-enriched ore is then reduced at a higher temp. and the outgoing CO is reunited with the producer gas. Hematite-type ores can be treated by this process, whereas magnetite does not lend itself to impregnation. In the first instance, partial reduction at 500° gives rise to 2 reaction zones, Fe_2O_3-Fe_3O_4 and Fe_3O_4-Fe, the former penetrating into the crystal much faster than the latter and creating ultra- and micropores in which Fe-catalyzed decompn. of CO occurs; thus, formation of C black extends throughout the bulk of the ore particles. In magnetite only the second reaction zone is present; as a result of this C is only deposited at the surface, and no appreciable impregnation can take place. Grain size, up to 3 mm., has no effect on the rate of impregnation. At equal total pressures of the gas, the rate is proportional to the partial pressure of CO; CO_2 is an inhibitor. Expts. with 2 kinds of ores contg. Fe_2O_3 88.4 and 61.1, SiO_2 5.1 and 31.2, CaO 2.6 and 2.4%, resp., with 500 g. of ore powder sifted through 0.5-mm. mesh and dried at 130°, producer gas CO 28, CO_2 3-8, H_2 3-7, N_2 55-61%, at 500° for 2 hrs., rate of gas flow 10 l./min., total vol. of gas 1200 l., showed the rate of reduction to increase with pressure. For the first ore, at 5, 10, 20 atm., the amt. of C after impregnation was 3.5, 9.5, 14.8%, resp.; with a rate of flow of 13 l./min., total vol. of gas 1000 l., at 15 atm., 14.9% C was obtained. At 20 atm., the amt. of C black formed is approx. that needed for subsequent complete reduction at the higher temp., with a slight excess. The yield in C is about 80% of the theoretical max., as evidenced by the 21% CO_2 content of the outgoing gas, as against 11.5, 17.5, and 19.5% at 5, 10, and 15 atm., resp. The temp. of 500° was found to be optimum. Fourfold variation of the rate of flow and corresponding variation of the time, the total vol. of gas being const., left the amt. of C formed unaffected. With the 61.1% Fe_2O_3 ore, impregnation was faster. The heat balance for 100 g. of the 88.4% Fe_2O_3 ore, including reduction of Fe_2O_3 to Fe_3O_4 + 2000 cal., 25% reduction Fe_3O_4 to FeO −1420 cal., sepn. of C by $2CO = C + CO_2$ + 10450 cal., heating of producer gas from 0° to 500° −3730 cal., heating of the ore from 0 to 500 −7500 cal., dehydration of the ore −2000 cal., shows a gain of +1300 cal.; in other words, there is no need for an external supply of heat. Depending on the amt. of C deposited at 500° and on the temp. of the subsequent high-temp. reduction, spongy or cast iron and steel can be produced in the operation. A sketch of a possible production installation is given.

N. Thon

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

2

Kinetics of reduction and dissociation of metal oxides. B. P. Tatievskaya and G. I. Chufarov. *Bull. acad. sci. U.R.S.S., Classe sci. tech.* 1946, 1005-14(in Russian).—The problem of existence or absence of correlation between the dissocn. equil. and the kinetics of dissocn. and of reduction of oxides was investigated on CuO and Cu_2O. The equil. pressures p of O_2 were calcd. from the heats H and entropies S at 298°K. by $\log p^{1/2} = -(H_{298}/4.573T) + (S_{298}/4.573) + [a\,f(T/298)/4.573]$ where a = sum of heat capacities and $f(T/298) = \ln (T/298) + (298/T) - 1$. Substituting the best values, one finds, at 300, 450, 600, 900, 1200°K, resp., for $2CuO = Cu_2O + {}^1/_2O_2$, $p = 1.2 \times 10^{-[illegible]}$, $3.3 \times 10^{-[illegible]}$, $8.3 \times 10^{-[illegible]}$, $2.4 \times 10^{-[illegible]}$, $3.3 \times 10^{-[illegible]}$ atm.; and for $Cu_2O = 2Cu + {}^1/_2O_2$, $p = 4.4 \times 10^{-[illegible]}$, $5.5 \times 10^{-[illegible]}$, $1.8 \times 10^{-[illegible]}$, $4.8 \times 10^{-[illegible]}$, $1.9 \times 10^{-[illegible]}$ atm., resp. Agreement with exptl. data for CuO is very good. It follows that the dissocn. pressure of CuO in the given temp. interval is about $10^{[illegible]}$ times higher than that of Cu_2O. In contrast thereto, the rates of reduction of both oxides by H_2 were found to be approx. equal, in measurements with initial H_2 pressures of 200, 100, and 50 mm. Hg. at 200 and 250°. At the latter temp. with 100 mm. H_2, 1 g. oxide, CuO evolved 0.088 g. O_2 in 40 min., Cu_2O 0.110 g.; the rate of reduction of Cu_2O is somewhat higher throughout than that of CuO. Complete reduction of 1 g. Cu_2O at 250° at initial H_2 = 200 and 100 mm. Hg. requires 15-20 and 50-60 min., resp. Both CuO and Cu_2O show a max. of rate of reduction at about halfway completion of the reaction, that is the kinetic curves of rate against time (or remaining H_2) are bell-shaped. From the rates at 200 and 250°, the apparent activation energies of reduction are found to be, for CuO, 13.3 kg.-cal./mol., for Cu_2O, 13.8 kg.-cal./mol, that is, very close. The rate of dissocn. of CuO into Cu_2O and O_2 is a linear function of the difference between the equil. dissocn. pressure of O_2 and the prevailing pressure: at 2 mm. O_2, 0.0012 and 0.0058 g. O_2/min. are evolved by 1 g. CuO at 850 and 900°, resp.; for very small O_2 pressures, the rate tends to a finite value which is many times smaller than that of reduction by H_2. The activation energy for the dissocn. CuO → Cu_2O is 40.0 kg.-cal./mol., from the rates at 850 and 900°. Since there is no relation between equil. and rate of dissocn. and the rate of reduction, the latter reaction is obviously wholly governed by adsorption of H_2 on the oxide surface. By the Brunauer-Emmett-Teller method of low-temp. N_2 adsorption, the surface areas of CuO and Cu_2O were detd. to be 0.203 and 0.167 sq.m./g., resp. The surface areas are thus of the same order of magnitude, which accounts for the approx. equality of the rates of reduction. The slight difference in favor of Cu_2O can be ascribed to a higher no. of active centers owing to removal of O atoms from the lattice as compared with CuO.

N. Thon

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

2ND AND 4TH ORDERS

C-7

7

Separation of cobalt and nickel by the hypochlorite method. A. K. Sharova, G. I. Chufarov, and M. S. Shace. *Tsvetnye Metal.* 19, No. 6, 44-8(1946).—This study concerned the optimum conditions for sepg. Co and Ni by pptg. the Co with NaOCl. A good sepn. was obtained at pH 5 in a soln. contg. 20-50 g. per l. of active Cl. After adding NaOCl the soln. is neutralized with 8% $NaHCO_3$ soln. (preferably) or a 2% soln. of Na_2CO_3 at room temp. The ppt. is washed with 0.01 *N* HCl or 0.01-0.05 *N* H_2SO_4.

M. Hosch

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

CA

18

Tungstic anhydride. A. K. Sharova, G. I. Chufarov, and M. S. Shore. U.S.S.R. 68,573, May 31, 1947. In the process are utilized materials, such as sheelite concentrates, various intermediates of W concentrating plants, and low-grade concentrates which because of impurities, e.g. P, Mo, and the like, cannot be treated by the generally accepted methods. These materials are fused with Na_2SO_4, sand, and coal. The fusion is carried out first in a reducing atm. and then in an oxidizing atm. This causes Na_2WO_4 to dissolve in Na_2SO_4 and as it is of relatively low sp. gr., to concentrate in the upper layer, whereas the lower heavier layer consists predominantly of silicates.

M. Hosch

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

CHUFAROV, G. I.

PA 9T97

USSR/Catalysis Apr 1947
Retardation apparatus

"On the Retardation of the Bell Reaction $2CO = C + CO_2$," G. I. Chufarov, M. F. Antonova, 10 pp

"Izv Ak Nauk Tekh Nauk" No 4 - pp. 381-9

Large table listing the various catalysts with their coefficients of retardation ('k' in the equation: $p + kp = o$). Twelve graphs showing the dependence between temperature, time, percentage composition, catalyst used, etc.

9T97

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

21

S

Methods of Oxidation and Hot Extraction in Determining Hydrogen in Metals. G. I. Chufarov and S. S. Nosyreva. (Zavodskaya Laboratoriya, 1947, vol. 13, pp. 287–288; Chemical Abstracts, 1948, vol. 42, May 20, col. 3283). The determination of hydrogen by oxidation of the metal with oxygen at moderate temperatures has a limited field of application. The method cannot be used for high-carbon steels because of the absorption of CO_2 by the plugs in the absorption tubes containing P_2O_5. It is also impossible to determine hydrogen by this method at temperatures of 800–1000° in the case of Nichrome, heat-resistant steels, and many other metals and ferrous alloys, because of the formation of a non-porous oxide film which prevents the penetration of the oxygen to the metal surface and the diffusion of the water vapours in the opposite direction.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

TATIYEVSKAYA, Ye. P., CHUFAROV, G. I., and ANTONOV, V. K.

"Kinetics of the Reduction and of Dissociation of the Oxides of Manganese," Dok. AN, 58, No. 9, 1947

Ural Branch Acad Sci USSR, Sverdlovsk

PROCESSES AND PROPERTIES INDEX

6

CA

Oxidation of iron sulfide by oxygen. G. I. Chufarov and B. D. Averbukh. *Zhur. Obshchei Khim. (J. Gen. Chem.)* **19**, 857-62(1949).—By analytical, manometric, x-
ray, and magnetic detns., FeS (prepd. either by fusion of
$Fe + S$ at 1200°, followed by treatment with 90% H_2 +
10% H_2S at 1050° and cooling in a stream of N_2, or by
dissocn. of FeS_2 in a stream of N_2 at 700°), of a surface
area of about 0.1 sq.m./g., is oxidized by dry O_2 at as low
a temp. as 50° or 100° and as low an initial pressure as 0.1
mm. However, under these conditions, the reaction stops
very soon; thus, at 50°, the total consumption of O_2
corresponds to a decrease of the pressure by 0.02 mm.
(= 3×10^{-6} g. O_2/0.5 g. FeS), at 100° to 0.1 mm., and
at 150° to 0.3 mm. At 50°, the amt. of product formed
corresponds to one, at 100-150° to 5-15 unimol. layers.
Up to 250°, the oxidation takes place without evolution
of gas; consequently the product is $FeSO_4$. The early
stoppage of the reaction is due to the dense structure of
this product. If the oxidized sample is heated to 600°
or higher, the $FeSO_4$ is partly dissocd. to a less dense
oxide, and the sample becomes susceptible to renewed low-
temp. oxidation. At 350-450°, owing to partial dissocn.
of $FeSO_4$, oxidation proceeds almost to completion, the
product being a mixt. of $FeSO_4$ and Fe oxides. Above
450°, the reaction is limited only by sintering of the
particles of the product, a mixt. of Fe_2O_3 with Fe_3O_4,
with the ratio Fe_2O_3/Fe_3O_4 increasing with the combustion of S. N. Thon

ASB-SLA METALLURGICAL LITERATURE CLASSIFICATION

CHUFAROV, G. I.,

Averbukh, B. D. and Chufarov, G. I., On the kinetics of reduction and dissociation of silver oxide. P. 37

The purpose of this work consists in the comparison of the rates of reduction and dissiciation of silver oxide which, as preceding works of our laboratory showed, makes it possible to approach the question concerning the mechanism of reduction processes in more detail.

Institute of Chemistry and Metallurgy of
the Ural Branch of the Aca. of Sci.,
USSR
Sverdlovsk
May 18, 1948

SO: Journal of Physical Chemistry (USSR) 23, No. 1 (1949)

CA

The rates of reduction of iron oxides. R. P. Tatievskaya, G. I. Chufarov, and V. K. Antonov (Acad. Sci. U.S.S.R., Sverdlovsk). *Zhur. Fiz. Khim.* 24, 385-93 (1950).—Although the equil. pressure (calcd.) of O_2 over Fe_2O_3 is much greater than over Fe_3O_4 or FeO, all 3 oxides are reduced by H at similar rates, showing that reduction is independent of dissocn. and that reduction of FeO is not the slowest stage in the reduction of higher oxides. The surface area of the oxides (from N_2 adsorption at $-195°$) was 0.85, 0.85, and 0.60 sq.m./g. for Fe_2O_3, Fe_3O_4, and FeO, resp. The oxides were heated in H_2, the H_2O formed was frozen out, and the rate v of reaction was calcd. from the decrease in pressure p. In one expt., v first increased to a max. at 10-30% reduction and then decreased again. When the original p (p_0) was 200 mm. Hg, the max. v of Fe_2O_3 was about 7, 16, 37, and 95×10^{-4} g. O for g. Fe_2O_3 and min. at 350, 400, 450, and 500°, resp.; the max. v of the other oxides were, e.g., 10% less. At reductions below 10%, v was proportional to p_0^n, and the const. n was 0.68 and 0.78 for Fe_2O_3 at 400 and 450°, 0.68 and 0.81 for Fe_3O_4, and 0.5 and 0.66 for FeO when p_0 varied from 0 to 320 mm. Hg. The apparent energies of activation were 16,800, 13,800, and 14,000 cal./mole.

J. J. B.

2

C.A.

Reduction and dissociation of oxides of cobalt and of nickel. G. I. Chufarov, M. G. Zhuravleva, and B. P. Tatievskaya (Inst. Chem. and Met., Ural Branch Acad. Sci. U.S.S.R., Sverdlovsk). *Doklady Akad. Nauk S.S.S.R.* 73, 1209-12(1950).—(1) The kinetic curves of the reduction of CoO, prepd. by dissocn. of 98% Co_3O_4 in a N_2 stream at 980° (resulting in a product 99% pure, sp. surface area 0.48 sq. m./g. by the N_2 adsorption isotherm), plotted in terms of the rate (g. O_2 taken off the oxide/min.) as a function of the degree of reduction, at 200, 250, 300, and 350°, in a closed system with circulating H_2 gas under 300 mm. Hg, show initial autocatalysis and a max. of the rate at about 25% reduction. The apparent activation energy is 13.0 kcal./mole. Under the same conditions, the curves for Co_3O_4 (98%) show a max., corresponding to reduction of Co_3O_4 to CoO, followed, at least at 350°, by a min. and a 2nd, lower max.; the part of the curve beyond the max. corresponds to reduction of CoO to Co. The rate of reduction of Co_3O_4 is approx. twice that of the reduction of CoO; the apparent activation energy is 12.3 kcal./mole. At equal degree of reduction, at const. temp., the dependence of the rate v on the pressure is expressed by $v = kp^n$ where n = a fraction tending to 1 with increasing temp. (2) The equil. dissocn. pressure of Co_3O_4 is independent of the O content in the solid phase as long as Co_3O_4 is present, i.e. no solid solns. are formed; at 700, 800, 880, and 900°, p = 0.5, 7.5, 27, and [illegible] mm. Hg. This can be represented by $\log p^{1/2} = -(H_{[illegible]}/4.573\ T) + (S_{[illegible]}/4.573)$, with $H_{[illegible]}$ = 38,790 cal./mole, $S_{[illegible]}$ = 31.23 cal./mole/degree; consequently, $\log p^{1/2} = -8483\ T^{-1} + 6.83$. In contrast to Co_3O_4, the dissocn. pressure of CoO even at 1000° is only $3.26 \times 10^{-[illegible]}$ atm. Despite the enormous difference of the equil. dissocn. pressures, the rates of the reduction of Co_3O_4 and CoO are comparable. (3) For NiO, prepd. by decompn. of $Ni(NO_3)_2$ at 950° (resulting in a product 98% pure, sp. surface area 5.43 sq. m./g.), the kinetic curves at 225, 250, 300, and 350° pass through a max. around 33% reduction; the activation energy is 16.0 kcal./mole. For a mixed NiO-Ni_2O_3, prepd. by prolonged heating of $Ni(NO_3)_2$ at 250° to const. wt., and analyzing NiO 60, Ni_2O_3 40%, the kinetic curves at 150–300° have 2 maxima, the 1st of which corresponds to reduction of Ni_2O_3, the 2nd to autocatalytic reduction of NiO. The equil. dissocn. pressures of Ni_2O_3, at 400, 500, and 600°, were detd. to 77, 111, and 151 mm. Hg. Hence, the thermal effect of the dissocn. of Ni_2O_3 in that temp. range is ~2 kcal./mole, and the entropy of Ni_2O_3 is 41.1 cal./mole/degree. For NiO, equil. dissocn. pressures, calcd. from the literature data, of $H_{[illegible]}$, $S_{[illegible]}$, and the heat capacities, at 500, 600, 700, 800, 900, 1000, 1100, and 1200°K., are, resp., $6.09 \times 10^{-[illegible]}$, $1.24 \times 10^{-[illegible]}$, $1.074 \times 10^{-[illegible]}$, $8.67 \times 10^{-[illegible]}$, $1.12 \times 10^{-[illegible]}$, $6.6 \times 10^{-[illegible]}$, 1.24×10^{-12}, and $9.4 \times 10^{-[illegible]}$ mm. Hg. Despite the very great difference of the equil. dissocn. pressures of Ni_2O_3 and NiO, their rates of reduction by H_2 are comparable. N. Thon

CHUFAROV, G. I.

USSR/Chemistry - Peroxides Apr 51

"Dissociation and Reduction of Barium and Calcium Peroxides," B. D. Averbukh, G. I. Chufarov, Inst of Chem and Metallurgy, Ural Affiliate, Acad Sci USSR

"Zhur Obshch Khim" Vol XXI, No 4, pp 626-631

Results of investigations show: (1) dependence of rate of dissocn of BaO_2 and CaO_2 on pressure of gaseous O_2; (2) apparent activation energies; (3) change in equil pressure for dissocn of BaO_2 due to content of O_2 in solid phase; (4) dependence of equil pressure of O_2 on temp in monovariant region. Discusses mech of reduction of BaO_2 and CaO_2.

182T15

PA 172T13

CHUFAROV G. I.

USSR/Chemistry - Inorganic Jan 51

"Separation of Sulfur and Selenium," M. G. Zhuravleva, G. I. Chufarov, Inst Chem and Metallurgy, Ural Affiliate, Acad Sci USSR

"Zhur Prik Khim" Vol XXIV, No 1, pp 28-31

Studied sepn of Se from S for recovery of pure S from flotation tailings. Over wide range of concn, coeff of activity for S and Se were greater than 1, indicating deviation from law for ideal soln. No azeotropic mixt were formed in S-Se system. Thus components can be sepd completely by distn.

172T13

CHUFAROV, G. I.

USSR/Chemistry, Metallurgy - Copper Jan 52

"Retarding Effect of Gaseous Reaction Products on the Rate of Reduction of Copper Oxides With Hydrogen and Carbon Monoxide," G. I. Chufarov, B. D. Averbukh, Ye. P. Zatievskaya, V. K. Antonov, Ural Affiliate, Acad Sci USSR, Inst of Chem and Metallurgy, Sverdlovsk

"Zhur Fiz Khim" Vol XXVI, No 1, pp 31-38

Gaseous products of the reaction, on being adsorbed at the reaction surface, bring about a sharp lowering of the rate of reduction. A quant

211T40

expression for the retarding effect of CO_2 is given. The retarding effect of water vapor is greater for cuprous oxide than cupric oxide, because the adsorption on cuprous oxide is greater. The relation between the values of adsorption of H_2 and CO is in good agreement with kinetic data for CuO. When Cu_2O is reduced with CO, there is recrystn of newly formed metallic copper, so that the rate of the reaction is greatly lowered.

211T40

General & Physical Chem - 2

CA

Retarding action of gaseous reaction products on the rate of reduction of manganese oxides by hydrogen and carbon monoxide. G. I. Chufarov, B. D. Averbukh, E. P. Tatievskaya, and V. K. Antonov (Ural Branch, Acad. Sci., Sverdlovsk). *Zhur. Fiz. Khim.* 26, 834-41(1952); cf. *ibid.* 31.— CO (p_1 = 200 mm. Hg) + x% CO_2 was circulated over Mn oxides at 350-450°, and the decrease of the partial
pressure p_1 was detd. by freezing out CO_2. The rate
of reaction $dp_1/dt = kp_1^m/p_2^n$; p_2 is the partial pressure
of CO_2, and k, m, and n are consts. For MnO_2 at 350°
n = 0.60; at 450° for Mn_2O_3 and Mn_3O_4 n was 0.94 and
0.50, resp. Reduction of Mn_3O_4 by H (50-150 mm. Hg,
450°) was retarded by H_2O more than reduction of Mn_2O_3.
Adsorption (a in 10^{-6} g. mol./sq.m.) at 100° and 50 mm.
Hg was for H, CO, and CO_2 on MnO_2 20.50, 3.35, and 1.55;
on Mn_2O_3 5.5, 8.1, and 4.9; on Mn_3O_4 0.25, 1.00, and 1.70;
and on MnO 0.85, 1.30, and 5.80. Between 20° and 100°,
a of CO and H on Mn_2O_3 and of H on Mn_3O_4 increased with
temp., and a of CO_2 on Mn_2O_3 and CO on Mn_3O_4 decreased.
At 10 mm. Hg and 100°, a for H and H_2O on Mn_2O_3 was 2.6
and 8.0, on Mn_3O_4 0.1 and 3.8, and on MnO 0.2 and 8.6,
resp. As a rule the rate of reduction increased with a, but
the energy of activation must be considered. The retardation of reaction by the reaction product generally was greater
the greater was the a of the reaction product as compared
with the a of the reducing gas. J. J. Bikerman

CHUFAROV, G.I.

See Timing Problems

CHUFAROV, G. I.

Chemical Abst.
Vol. 48 No. 9
May 10, 1954
Metallurgy and Metallography

5 Mct

Effect of flux moisture on dip-tinning of iron. G. I. Chufarov, M. G. Zhuravleva, E. P. Tatievskaya, B. D. Averbukh, and V. K. Antonov. *Zhur. Priklad. Khim.* 26, 652-5(1953).—In dip-tinning of Fe, excessive H_2O in $ZnCl_2$ flux dissolves Fe rapidly and forms $FeSn_2$ scum and sludge. This increases Sn consumption and contaminates the coating with scum. When the flux is almost anhyd., cleaning of Fe is very slow and bare spots may remain on the surface. The optimum H_2O content of the flux is 1.5-3.5%, corresponding to b.p. 250-275°. The b.p. is an important characteristic of the flux. B. M. Elkin

CHUFAROV, G. I.

USSR/Chemistry - Metallurgy

Card 1/1

Authors : Tatievskaya. E. P., Chufarov, G. I., and Stafeyeva, N. M.

Title : Reduction of cupric oxides with graphite

Periodical : Zhur. Fiz. Khim., 28, Ed. 5, 843 - 850, May 1954

Abstract : The rate of reduction of CuO and Cu_2O with graphite in vacuum and in the presence of gaseous reaction products was investigated. Pure carbon dioxide was found to be the product of the reduction reaction. The rate of reduction of cupric oxides with graphite in the presence of a gaseous reaction product is greater than in vacuum which indicated the participation of the gaseous phase in the reduction process. The reduction with a solid reducing agent consists of two phases: reduction of the oxide with carbon monoxide and the reaction of the formed CO_2 with the graphite. Nineteen references: 14-USSR, 2-German, 2-English and 1-USA. Graphs, drawing.

Institution : Acad. of Sc. USSR, Ural Branch, Institute of Chemistry and Metallurgy, Sverdlovsk

Submitted : Aug. 23, 1953

... adsorption catalytic theory of the ... school, the adsorption ... solid reducing agents is developed. metal oxides by CO, hydrogen or solid reducing ... Complex Reduction and Oxidation of Elements. ... 33 63. This is a comprehensive discussion ...

Chubarov, S. I.; Ivliyevskaya, E. P.

Slag Formation in Blast-Furnaces. L. M. Tsylev. (232–239). Softening curves for iron ores and sinter and manganese ores are presented together with data on slag [illegible] formation of primary slags in [illegible]

[illegible]

Mineralogical Control of Blast-Furnace [illegible]

[illegible] and some examples of the application of [illegible] logical examination to the elucidation of [illegible]

[illegible] Blast-Furnace Process

[illegible] Experience in Smelting [illegible] manganese [illegible]

CHUFAROV, G. I.

USSR/Chemistry

Card 1/2

Authors : Chufarov, G. I., Averbukh, B. D., Tatievskaya, E. P., and Antonov, V. K.

Title : Inhibiting effect of gaseous reaction products on the rate of reduction of ferric oxides with hydrogen and carbon monoxide.

Periodical : Zhur. Fiz. Khim. 28, Ed. 3, 490-497, March 1954

Abstract : The authors investigated the effect of gaseous reaction products on the rate of reduction of ferric oxides with carbon monoxide and hydrogen in a pressure range of from 100-250 mm mercury column and also measured the adsorption of basic gases and gases obtained during reduction on the surfaces of the oxides. The inhibiting effect of the gaseous reaction product CO_2 during the reduction of Fe_3O_4 and FeO with carbon monoxide can be computed quantitatively by calculating the rate of reaction according to a certain equation. During reduction of Fe_3O_4 with carbon monoxide and hydrogen at temperatures above 700° there is practically no inhibiting effect of the reaction products during the initial stages, but after

Zhur. Fiz. Khim, 28, Ed. 3, 490-497, March 1954 (additional card)

Card 2/2

Abstract : Reduction reached 11%, when a greater amount of Fe_3O_4 is formed, the inhibiting effect of carbon monoxide and water vapor becomes great. The experimental material on the inhibiting effect of gaseous reaction products on the rate of reduction of the investigated ferric oxides is in agreement with the data regarding the adsorption of gaseous reducing agents and reaction products on the surface of the mentioned oxides. Seven U.S.S.R. references 1 since 1937. Graphs.

Institution : Acad. of Sc. U.S.S.R. Ural Branch, Institute of Chemistry and Metallurgy, Sverdlovsk

Submitted : June 15, 1953

CHUFAROV, G. I.

USSR/ Chemistry - Reduction

Card 1/1 Pub. 22 - 28/47

Authors : Arkharov, V. I.; Bogoslavskiy, V. N.; Zhuravleva, M. G.; and Chufarov, G. I., Memb. Corresp. of Acad. of Sc. USSR

Title : Reduction of ferric oxides with graphite

Periodical : Dok. AN SSSR 98/5, 803-806, Oct 11, 1954

Abstract : The reduction of Fe_2O_3 with graphite at temperatures of 1000 - 1150° in vacuo was investigated. The gaseous reaction products were continuously removed through a trap cooled with liquid air for the purpose of collecting the CO_2. The amount of carbon monoxide (CO) formed during the reduction process was determined by the difference between loss in weight and amount of CO_2 lost through freezing. Data regarding rate of reduction and apparent activation energy values are presented. Results of x-ray analysis of the solid reduction products are shown in table. Seven references: 6-USSR and 1-German (1925-1945). Table; graph.

Institution : Acad. of Sc. USSR, Ural Branch, Institute of Chemistry and Metallurgy

Submitted : March 31, 1954

CHUFAROV, G. I.

Problems of charcoal utilization. V. N. Kozlov and G. I. Chufarov. *Trudy Inst. Khim. i Met., Akad. Nauk S.S.S.R., Ural. Filial* 1955, No. 2, 5-9.—Efficient utilization of charcoal in metallurgical practice is discussed in detail. (1)

Elisabeth Barabash

MG

2029. POSSIBLE TREATMENT OF WOOD TAR IN URAL. [illegible]
[illegible] and Averbukh, B.D. Trud. [illegible]

of the birch (I) and pine (II) tars were studied. [illegible]
gasoline (III) can be produced by cracking the fraction of I, boiling at [illegible]
[illegible]

CHUFAROV, G.I.

USSR.

9341* Investigation of the Reduction of Iron Oxides by Graphite. "Issledovanie vosstanovleniia okislov zheleza grafitom." (Russian.) V. I. Arkharov, V. N. Bogoslovskii, M. G. Zhuravleva, and G. I. Chufarov. Zhurnal Fizicheskoi Khimii, v. 29, no. [illegible], Feb. 1955, p. [illegible].

Vacuum reduction performed at various temperatures, and the dependence of the Wüstite lattice parameter on degree of reduction. Graphs. 10 ref.

M [illegible]

CHUFAROV, G. I.

2

Kinetics of reduction of oxides of iron by gaseous reducing agents at low temperatures. A. G. Moskvicheva and G. I. Chufarov (*Dokl. Akad. Nauk SSSR*, 1955, 105, 510—513).—The velocity of reduction of finely powdered Fe_2O_3 by CO at 225—300°/240—260 mm. rises to a max. when 2·5—7·5% reduction has been achieved, and then falls to a min. at 11% reduction, corresponding with completion of the process $Fe_2O_3 \rightarrow Fe_3O_4$, and commencement of reduction of Fe_3O_4 to Fe; no break in the velocity curve corresponding with formation of FeO is observed. The initial autocatalytic stage is not evident with reduction by H_2, owing to adsorption of H_2O at active regions of the Fe_2O_3–Fe_3O_4 reaction zone. Similar effects are found when the pressure is reduced to 0·01 mm. The process is thought to consist of the stages: (i) re-arrangement of the α-Fe_2O_3 corundum-type lattice to the Fe_3O_4 spinel-type lattice, possibly through γ-Fe_2O_3, in which some of the Fe places are vacant, (ii) further removal of O'' ions, leaving surface excess of Fe ions, which diffuse into the interior to fill Fe vacancies in the Fe_3O_4 lattice, and (iii) reduction of Fe_3O_4 to α-Fe, after completion of the Fe_3O_4 lattice. With large crystals of Fe_2O_3 stages (ii) and (iii) may co-exist.

R. TRUSCOE.

CHUFAROV, G.I.

B-9

USSR/Physical Chemistry, Kinetics, Combustion, Explosion, Topochemistry, Catalysis.

Abs Jour : Ref Zhur - Khimiya, No 7, 1957, 22426.

Author : B. D. Averbukh, G. I. Chufarov.
Inst : Not given
Title : The influence of metal oxides admixtures on Mn_3O_4 reduction by carbon.

Orig Pub : Zh. fiz khimii, 1956, 30, No 8, 1739-1745 (res.angl).

Abstract : The influence of metal oxides and alkali- and alkali earth metals salts on the rate of Mn_3O_4 (I) reduction by solid carbon in a vacuum at 750-950° is studied. Easily reducible oxides Cu_2O, Fe_3O_4, Ag_2O, NiO and Co_3O_4 in quantities of 5% of I weight do not influence materially the rate of reduction; but the difficultlyreducible oxides CaO, MgO, SiO_2 and Al_2O_3 delay I reduction, probably by formation of a surface compound with I. Addition of 1-10% of $CaCO_3$ or Na_2CO_3 does not influence considerably reduction of I by graphite. Additions of 1-10% of K_2CO_3 also of KOH accelerate considerably reduction of I by graphite and by birch coal. Maximum of acceleration is obtained at 3% of K_2CO_3. The reduction of I by birch coal is

Card 1/2

CHUFAROV, G.I.

Some problems in the theory of metallurgical processes. Priroda 45 no.8:85-88 Ag '56. (MLRA 9:9)

1.Chlen-korrespondent Akademii nauk SSSR.2.Ural'skiy filial Akademii nauk SSSR, Sverdlovsk.
(Metallurgy)

SOV/137-58-12-24275

Translation from: Referativnyy zhurnal. Metallurgiya, 1958, Nr 12, p 50 (USSR)

AUTHORS: Diyev, N. P., Chufarov, G. I.

TITLE: Contribution to the Investigation of the Problems of Heavy Nonferrous-Metals Metallurgy (K issledovaniyu problem metallurgii tyazhelykh tsvetnykh metallov)

PERIODICAL: Tr. In-ta metallurgii. Ural'skiy fil. AN SSSR, 1957, Nr 1, pp 5-13

ABSTRACT: A review of studies of the Institute of Metallurgy, Academy of Sciences, USSR, in which special attention is given to questions of oxidation of the sulfides of the nonferrous metals and to complex utilization of raw material.

L. S.

Card 1/1

CHUFAROV, G.I.

137-58-4-6761

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 4, p 65 (USSR)

AUTHORS: Diyev, N. P., Chufarov, G. I.

TITLE: Investigation of Problems of the Metallurgy of the Heavy Non-ferrous Metals at the Institute for Metallurgy of the Urals Branch, Academy of Sciences, USSR (Issledovaniye problem metallurgii tyazhelykh tsvetnykh metallov v Institute metallurgii Ural'skogo filiala AN SSSR)

PERIODICAL: Izv. vost. fil. AN SSSR, 1957, Nr 8, pp 143-154

ABSTRACT: A review of the work done by the Institute for Metallurgy of the Urals Branch, Academy of Sciences, USSR. Bibliography: 58 references.

G. S.

1. Metallurgy--Bibliography 2. Scientific reports--Review

Card 1/1

CHUFAROV, G.I.

AUTHORS: Lisnyak , S. S., Tatiyevskaya, Ye. P. 20-4-35/51
Chufarov, G. I., Corresponding Member of the AN USSR.

TITLE: The Reduction of Higher Iron Oxides by Graphite and Charcoal With the Addition of Na_2CO_3 and K_2CO_3 (Vosstanovleniye vysshikh okislov zheleza grafitom i drevesnym uglem s dobavkami Na_2CO_3 i K_2CO_3).

PERIODICAL: Doklady AN SSSR, 1957, Vol. 116, Nr 4, pp. 656-659 (USSR)

ABSTRACT: The purpose of present investigation is the clearing of the kinetics and of the mechanism of the reaction mentioned in the title, since there are only few data about it in the papers published up to now. The experimental method is described. Figure 1 shows that the reduction of iron oxide by charcoal takes place with a considerable velocity already at 700°. At 750° the reduction took place quicker than in the case of use of graphite at 850°. The addition of Na_2CO_3 and K_2CO_3 accelerated the reduction by charcoal at 700° only to an unimportant extent. In the case of graphite the acceleration at 800° was greater. The reduction of the magnetic iron oxide began at800° (figure 2), by graphite at 950° (figure 3). The addition of Na_2CO_3 and K_2CO_3 accelerated the reduction velocity of Fe_3O_4 by both coal species. This was the case with charcoal at 800° to an unimportant extent. The addition of the two carbonates at 850° accelerated the reaction to a great

Card 1/3

The Reduction of Higher Iron Oxides by Graphite and Charcoal With the Addition of Na_2CO_3 and K_2CO_3. 20-4-35/51

extent. In the case of graphite (figure 3) and at 900-1000° the acceleration was also greater. The addition of K_2CO_3 was in all cases more efficient than that of Na_2CO_3. The reduction velocity by charcoal decreases in the course of the process. In the case of graphite a minimum occurs which corresponds to the begin of the reduction of $FeO \rightarrow Fe$. Furthermore the CO_2- concentration in the gas-like reaction products is discussed. According to the present conception of the reduction mechanism of the iron oxides by carbon this process takes place by means of the developing carbon oxide: $Fe_xO_y + CO \rightarrow Fe_xO_{y-1} + CO_2$, $CO_2 + C \rightarrow 2CO$. The acceleration of the reduction of the higher iron oxides is explained by the fact that in the case of using graphite the velocity of the carbon oxide formation is lower than in the case of charcoal. The reduction of Fe_3O_4 up to FeO at higher temperatures is explained by the fact that the gas necessary for it cannot be produced with a CO_2 content higher than 60 - 80%, in consequence of the temperature rise. The influence of Na_2CO_3 and K_2CO_3 can be connected 1) with the formation of surface compounds which facilitate the processes of the adsorption-chemical interaction, 2) with the penetration of atoms or ions of the alkali metals into the lattice of the oxide and the carbon. This leads to an increase of the

Card 2/3

CHUFAROV, G.I.; TATIYEVSKAYA, Ye.P.; ZHURAVLEVA, M.G.; AVERBUKH, B.D.; LISNYAK, S.S.; ANTONOV, V.K.; BOGOSLOVSKIY, V.N.; STAFEYEVA, N.M.

Kinetics and mechanism of the reduction of metal oxides and chemical compounds. Trudy Inst. met. UFAN SSSR no.2:9-40 '58. (MIRA 12:4)

(Oxidation-reduction reaction) (Metallurgy)

5(2)

AUTHORS: Bogoslovskiy, V. N., Zhuravleva, M. G., Chufarov, G. I., Corresponding Member, Academy of Sciences, USSR

SOV/20-123-1-22/56

TITLE: On the Reduction of Nickel Ferrite by Graphite (O vosstanovlenii ferrita nikelya grafitom)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol 123, Nr 1, pp 87 - 89 (USSR)

ABSTRACT: The mechanism of crystallochemical transformations in the reduction of metal oxides by graphite has been intensely studied on iron oxides (Ref 1). But in the reduction of complicated compounds, in the crystal lattice of which atoms of various metals are occurring, essential deviations might be expected. Ferrites of the type $Me^{2+}Fe_2^{3+}O_4$ and such with a spinel structure are worth to be thoroughly investigated as they represent a valuable material in the production and use of semiconductors. The nickel ferrite investigated was produced by sintering of an equimolar mixture of Fe_2O_3 and NiO for 30 hours at 1200°. As reducing

Card 1/4

agent, graphite from Acheson electrodes was used which was annealed in the vacuum at 1100°. Ferrite was carefully powdered with graphite and then subjected to reduction. The amount of graphite was three times the quantity theoretically required for a complete reduction, the annealing was performed in the air, but the gaseous reaction products were always pumped off and CO_2 was gathered in a trap dipped into liquid nitrogen, and periodically determined. Table 1 shows the variation of the rate of the reduction process of nickel ferrite at 950° in dependence upon the oxygen amount withdrawn. Initially, up to 20% of this amount, the rate is somewhat reduced. After the withdrawal of 45-50 % oxygen the rate of reduction considerably increases and reaches the maximum at 80%. This kind of kinetics points to the essential role of the crystallochemical transformations during the reduction. The X-ray investigation of the solid products of reduction showed that they consist at the beginning (up to 20%) of nearly pure metallic nickel. Its lattice parameter is

On the Reduction of Nickel Ferrite by Graphite SOV/20-123-1-22/56

3.517 - 3.520 Å. Later, the parameter of the lattice of the metallic phase increases, which enlightens the increasing iron content in the nickel. The dependence of the mentioned lattice parameter of the metallic phase upon the oxygen content in the solid phase is given in figure 2. The parameter is maintained on further reduction up to 50% of the reduction and then increases again. The maximum of 3.581 Å is reached at 70%. The reduction mechanism of nickel ferrite by graphite in vacuo is determined both by the ion diffusion in the surface layer and by the steric ion diffusion in the depth of the crystal lattice. This mechanism differs from the reduction by gases (f.i.by hydrogen at 400°), in which the steric diffusion is without importance and where the lattice transformations is mainly achieved by the superficial ion diffusion. There are 3 figures and 2 references, 1 of which is Soviet.

ASSOCIATION: Institut metallurgii Ural'skogo filiala Akademii nauk SSSR (Institute of Metallurgy of the Ural Branch of the Academy of Sciences, USSR)

Card 3/4

CHUFAROV, G.I.; AVERBUKH, B.D.; VETRENKO, Ye.A.

Kinetics of zinc sulfide reduction by carbon monoxide and hydrogen. Trudy Inst.met.UFAN SSSR no.3:43-50 '59. (MIRA 13:4)
(Zinc--Metallurgy)

ZHURAVLEVA, M.G.; CHUFAROV, G.I.

Reduction of nickelous and cobaltous oxides by graphite. Trudy Inst.met.UFAN SSSR no.3:63-66 '59. (MIRA 13:4)
(Nickel--Metallurgy) (Cobalt--Metallurgy)

67764

5.2200(c)
18.8100

SOV/126-8-5-17/29

AUTHORS: Stafeyeva, N.M., Bogoslovskiy, V.N., Chufarov, G.I., and Subbotina, V.A.

TITLE: Reduction of Copper Ferrite with Graphite

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, 1959, Nr 5, pp 740-746 (USSR)

ABSTRACT: The authors describe their investigation of the kinetics and mechanism of the reduction of the tetragonal and cubic forms of copper ferrite $CuFe_2O_4$ with graphite in vacuum. The graphite powder was prepared by grinding Acheson electrodes and calcination at 1200 °C without air and in a vacuum at 1000 °C. The ferrite was obtained from a mixture of the composition $CuO.Fe_2O_3$ by heating in air at 1000 °C for 30 hours. By cooling rapidly in water the cubic form was obtained; holding at 700 °C and cooling slowly gave the tetragonal form. For the reduction a previously described (Ref 6) apparatus with a quartz spring balance was used, the sample weight being 0.5 g ferrite and 0.15 g graphite. Preliminary degassing of the thoroughly mixed sample was effected at 300 °C and 10^{-5} mm Hg. The weight-loss was determined together with the corresponding weight of

Card 1/3

67764

SOV/126-8-5-17/29

Reduction of Copper Ferrite with Graphite

carbon dioxide evolved (trapped in a low-temperature trap) and from the difference the weight of carbon monoxide was calculated. The solid reaction products were studied by X-ray diffraction, the lattice parameters being determined by graphical extrapolation. Fig 1 shows rates of reduction as functions of degree of reduction at 650, 700, 750, 800, 900 and 1000 °C for tetragonal ferrite; Fig 2 shows the curve for 900 °C. The corresponding curves for the tetragonal and cubic ferrites are compared in Fig 3. Fig 4 shows degrees of reduction as functions of time for the tetragonal form at 800 and 900 °C, and Fig 5 the lattice parameter of this ferrite with respect to reduction temperature. For both forms the reduction occurs in a stepwise manner: $CuFe_2O_4 \rightarrow Cu + Fe_3O_4$; $Fe_3O_4 \rightarrow FeO$; $FeO \rightarrow Fe$. At 650, 700, 750, and 800 °C only the first stage occurs, at 900 °C and over all three. The reduction rates of the first and third stages show a maximum. By reducing the tetragonal form above the transformation temperature a solid solution of iron in copper is obtained, this being associated with the simultaneously occurring process of the transformation

Card 2/3

67764

SOV/126-8-5-17/29

Reduction of Copper Ferrite with Graphite

of the tetragonal copper-ferrite lattice into the cubic. The authors suggest the following reduction mechanism. As oxygen is removed from the ferrite surface an excess of iron and copper ions is produced. Copper being less firmly attached to oxygen forms a metallic phase, while the iron diffuses into the ferrite particle, displacing copper. Part of the trivalent iron ions are reduced to the bivalent form, the ferrite lattice then approximating to that of magnetite. After all the ferrite has been converted to magnetite the reduction of the latter begins, which proceeds as described by Arkharov, Bogoslovskiy, Zhuravleva and Chufarov (Ref 7).

There are 5 figures, 1 table and 7 references, of which 3 are Soviet, 2 French, 1 English and 1 Acta Crystallographica.

Card 3/3

ASSOCIATION: Institut metallurgii UFAN SSSR (Institute of Metallurgy, Ural Branch of Acad.Sci. USSR)

SUBMITTED: March 18, 1959

SOV/80-32-5-41/52

5(2)

AUTHORS: Zhuravleva, M.G., Bogoslovskiy, V.N., Chufarov, G.I.

TITLE: The Reduction of Nickel and Cobalt Ferrites by Hydrogen

PERIODICAL: Zhurnal prikladnoy khimii, 1959, Vol 32, Nr 5, pp 1159-1161 (USSR)

ABSTRACT: Ferrites are complex oxides of the formula MFe_2O_4, where M is a bivalent metal ion. The ferrite formation of the mixtures $NiO + Fe_2O_3$ and $CoO + Fe_2O_3$ starts at 700 - 800°C. At 1,100°C the reaction proceeds very intensively. After calcination for 30 hours, cobalt ferrites have a crystal lattice of 8.376 ± 0.003Å, nickel ferrites of 8.333 ± 0.005 Å. The reduction by hydrogen was carried out in a closed apparatus at 300 - 500°C and 200 mm Hg. The ferrites are reduced as chemical compounds without preliminary decomposition to oxides. The final product is a solid solution of metals.
There are 3 graphs and 5 Sov' t references.

~~Card 1/2~~

Sverdlovsk Inst. Metallurgy Ural Branch AS USSR

SOV/76-33-8-28/39

5(4)

AUTHORS: Lisnyak, S. S., Chufarov, G. I. (Moscow)

TITLE: Influence of the Additions of K_2CO_3, Na_2CO_3, Al_2O_3, and SiO_2 on the Kinetics of the Reduction of Magnetic Iron Oxide With Coal

PERIODICAL: Zhurnal fizicheskoy khimii, 1959, Vol 33, Nr 8, pp 1840-1846 (USSR)

ABSTRACT: It has been noted (Refs 1-4) that the rate of reduction of iron oxides depends on the type of coal used, as well as on the alkali and alkaline-earth additions in the layers. In the present case, the influence of K_2CO_3 (I) and Na_2CO_3 (II) additions (1% by weight) as well as Al_2O_3(III) and SiO_2 (IV) (5% by weight) was investigated. Magnetite (V) was obtained by the oxidation of iron sponge with CO_2 at 800°C. The reducing agent was Acheson graphite (A) and charcoal (C) (birch charcoal). The studies were made in a unit (Fig 1) which permitted the analysis of the gaseous reaction products without interrupting the experiment. The reduction of (V) with (C) and the additions took place at 800-900°, while the experiments with (A) were carried out, in the main at 950-1050°C.

Card 1/3

SOV/76-33-8-28/39

Influence of the Additions of K_2CO_3, Na_2CO_3, Al_2O_3, and SiO_2 on the Kinetics of the Reduction of Magnetic Iron Oxide With Coal

It was found that the reduction with (C) takes place at lower temperatures than it does with (A), which is explained by the faster formation of CO (by which the reduction is caused) in the former case. The additions of (I) and (II) accelerated the reduction, (II) having a stronger effect than (I). The accelerating effect of (I) and (II) is explained by the introduction of the potassium and/or sodium ions or atoms into the oxide lattice and the (C)-lattice (or (A)-lattice), by which the adsorption- and chemical-reaction processes are facilitated, and chemical surface compounds are formed as well. The addition of (III) or (IV) either did not influence the reduction process at all, or formed iron aluminates and/or silicates, and inhibited the process by reducing the CO formation. The results of the investigations suggest that the reduction of (V) with (C) in a vacuum takes place simultaneously in two reaction zones, while there is one reaction zone only in the case of (A). There are 4 figures and 14 references, 9 of which are Soviet.

Card 2/3

SOV/76-33-8-28/39

Influence of the Additions of K_2CO_3, Na_2CO_3, Al_2O_3, and SiO_2 on the Kinetics of the Reduction of Magnetic Iron Oxide With Coal

ASSOCIATION: Ural'skiy filial Akademii nauk SSSR Institut metallurgii Sverdlovsk
(Urals Branch of the Academy of Sciences USSR, Institute of Metallurgy Sverdlovsk)

SUBMITTED: February 12, 1958

Card 3/3

5 (1) SOV/20-126-3-46/69

AUTHORS: Zhuravleva, M. G., Bogoslovskiy, V. N., Chufarov, G. I., Corresponding Member AS USSR

TITLE: The Effect of Potassium and Sodium Carbonates on the Reduction of Nickel and Cobalt Ferrites by Graphite (Vliyaniye uglekislykh soley kaliya i natriya na vosstanovleniye ferritov nikelya i kobal'ta grafitom)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 126, Nr 3, pp 623-625 (USSR)

ABSTRACT: The authors used "achesonovskiy" [Abstracter's Note: Acheson's ?] graphite which was vacuum-annealed at 1100° as a reducing agent for the ferrites mentioned in the title. Its quantity was in every test 3 times the quantity necessary for reduction to the metal. The admixtures of the two carbonates amounted to 1 % of the ferrite weight. A vacuum in the order of magnitude of 10^{-3} mm mercury column was maintained in the reaction area. Figure 1 represents graphically the test results which show that the mentioned salts speed up the reduction referred to: K_2CO_3 by 100 fold for nickel ferrite, and by several dozens for cobalt ferrite. The efficiency of Na_2CO_3

Card 1/3

The Effect of Potassium and Sodium Carbonates on the Reduction of Nickel and Cobalt Ferrites by Graphite

SOV/20-126-3-46/69

is much lower (Figs 1a and 1b). The influence of the admixtures is not restricted to a simple acceleration - they also may change the character of the process (Ref 3). X-ray structure investigations of the solid phase have shown that, in the nickel reduction by graphite, metallic nickel is formed in the first stage, while the initial ferrite approaches the magnetite. In further reduction, the metallic phase is enriched by iron (Fig 2). The authors carried out an X-ray structure analysis of the solid products of a nickel-ferrite reduction by graphite with an addition of 1% K_2CO_3. It was found that in this case the reduction product is a solid solution Ni-Fe with a variable concentration. The phase with a lattice of the spinel type, i.e. ferrite, is present until the 71 % reduction is finished. At a 51 % reduction, a phase with a lattice of the NaCl type appears for the first time. It corresponds to the solid solutions $Fe_{1-x}Ni_xO$. Figure 2, however, shows that the lattice parameter is higher at the reduction with admixtures. This points to a higher iron content, and proves that the rate of spatial diffusion of the ions in

Card 2/3

The Effect of Potassium and Sodium Carbonates on the Reduction of Nickel and Cobalt Ferrites by Graphite SOV/20-126-3-46/69

the solid phase is inferior to the rate of oxygen extraction by the reducing substance. In the case of graphite, it is the gaseous carbon oxide. The present experimental material renders possible some suppositions on the possible mechanism of influence of the mentioned admixtures (Refs 3, 5, 6). Their introduction changes the reactivity of the oxides and ferrites, i.e. it changes the rate of the process. There are 2 figures and 7 Soviet references.

ASSOCIATION: Institut metallurgii Ural'skogo filiala Akademii nauk SSSR (Institute of Metallurgy of the Ural Branch of the Academy of Sciences, USSR)

SUBMITTED: March 16, 1959

Card 3/3

5 (1,2) SOV/20-126-4-39/62

AUTHORS: Lisnyak, S. S., Chufarov, G. I., Corresponding Member AS USSR

TITLE: On the Accelerating Effect of Potash Addition on Magnetite Reduction With Graphite (Ob uskoryayushchem vliyanii dobavki potasha na vosstanovleniye magnetita grafitom)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 126, Nr 4, pp 831 - 833 (USSR)

ABSTRACT: As is known 2 processes take place simultaneously in metal reductions by means of solid carbon: a) reduction of the oxides by means of gaseous CO and b) coal gasification by CO_2. Moreover, it is known that additions of alkali metal salts may accelerate the reduction both by gaseous (Refs 1-3) and by solid (Refs 4-6) reducing substances. They may also accelerate the mentioned gasification of the carbon (Refs 9,10). In this connection it must be determined whether the mentioned additions act on the two metal reduction reactions by solid carbon to the same degree or to different degrees. For the purpose of solving this problem the authors investigated the effects, brought about by the introduction of K_2CO_3 (2 wt %): first on oxide and

Card 1/4

then on graphite. Experiments without additions were carried out for the purpose of comparison. The initial materials as well as the methods are given in reference 6. As is shown by figure 1 the reduction rate in using graphite at 950° was the same, both, with addition or without. A potash-addition to the oxide, however, led to a considerable acceleration of the process at 950° as well as at 1000°. It may be seen from figures 2 and 3 that in the case of a previous roasting of graphite or of the oxide with potash at 1000° for 4 hours the introduction of the addition into the graphite did not change the rate of reduction: the potash-addition to Fe_3O_4 however, considerably accelerated this process. By means of special experiments it was found that if a mixture Fe_3O_4 + 2% K_2CO_3 is roasted at 900° in the vacuum for 2 hours 0.73% K_2O is obtained in the oxide. The CO_2 formed due to the decomposition of K_2CO_3 and part of the K_2O escape. In roasting Fe_3O_4 + 2% K_2CO_3 at 1000° for 4 hours 0.25% K_2O remain in the oxide. As is known

On the Acceleration Effect of Potash Addition SOV/20-126-4-39/62
on Magnetite Reduction With Graphite

K_2O is very volatile. A part of its molecules is absorbed in the process of roasting and in the reduction on the reaction surface of the oxide being reduced. For this reason the concentration of the electronic and the hole gas in the crystals is changed (Ref 7). This brings about a change of the reactivity of the oxide. The result which seems to be in contrast with the data from publications (Refs 9-13), according to which the reducing power of graphite after the roasting with K_2CO_3 at 900-1000° is not changed, is due to different conditions of interaction of the authors compared with the papers mentioned. From the results the conclusion is drawn that the potash addition acts on the interaction of CO (the actually reducing substance) and not on the reaction of the gasification $C + CO_2 = 2\ CO$. There are 3 figures and 13 references, 9 of which are Soviet.

Card 3/4

On the Acceleration Effect of Potash Addition on Magnetite Reduction With Graphite SOV/20-126-4-39/62

ASSOCIATION: Institut metallurgii Ural'skogo filiala Akademii nauk SSSR (Institute of Metallurgy of the Urals Branch of the Academy of Sciences, USSR)

SUBMITTED: March 16, 1959

Card 4/4

CHUFAROV, G. I.

66427

~~5 (2)~~ 18.7110, 15.2000

SOV/20-128-6-32/63

AUTHORS: Stafeyeva, N. M., Bogoslovskiy, V. N., Chufarov, G. I., Corresponding Member AS USSR, Subbotina, V. A.

TITLE: Reduction of Copper Ferrite by Graphite

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 128, Nr 6, pp 1210 - 1213 (USSR)

ABSTRACT: The authors investigated the kinetics and mechanism of the reduction of tetragonal and cubical copper ferrite in the vacuum. The graphite used for this purpose was prepared from pulverized Acheson electrodes by roasting at 1200° without access of air, then at 1000° in the vacuum. The ferrite was annealed in the air in a mixture of $CuO \cdot Fe_2O_3$ at 1000° for 30 hours. The products of sintering were exposed for 3 hours at 700° for obtaining a product with tetragonal lattice, and cooled down together with the furnace. The cubical form was obtained by quenching in water directly after annealing. The ferrite quantity weighed was carefully pulverized with graphite. The experiments were made in a vacuum apparatus (Ref 6). The reduction was carried out both below the point of transformation (760°) of tetragonal ferrite

Card 1/3

66427

SOV/20-128-6-32/63

Reduction of Copper Ferrite by Graphite

into the cubical form (spinel), i.e. at 650, 700 and 750°, and above this point (800, 900, 1000°). Figures 1 and 2 show the curves of reduction of tetragonal ferrite. Below 900°, a low-percentage reduction (11,18,24 and 35%, respectively) was attained. At 900 and 1000°, the sample was reduced with 100%. The initial stage of reduction exhibits the highest reaction rate. Then it falls rapidly, and is very low at a reduction of 40-50%. Above 50%, the reaction is again accelerated (Fig 2, right-hand side). Figure 3 compares kinetic curves representing the dependence of the reduction rate of tetragonal and cubical ferrite on the reduction degree at 700, 800 and 1000°. This shows that the reduction rate of cubical ferrite, at equal temperatures, is lower than that of tetragonal ferrite. Besides, there is no maximum rate in the 1st stage, in the case of cubical ferrite. At the beginning, the gaseous reaction products consist of CO and CO_2-mixture (60-65% CO_2). After a 70% reduction, they consist of almost pure CO. Subsequently, the roentgenogram of the solid reaction products is discussed, and a presumable mechanism of the crystal-chemical transformation during the reduction of the two forms is suggested: $CuFe_2O_4 \rightarrow Cu + Fe_3O_4$; $Fe_3O_4 \rightarrow FeO$; 4

Card 2/3

66427

Reduction of Copper Ferrite by Graphite SOV/20-128-6-32/63

$FeO \rightarrow Fe$. The reconstruction of the lattice of tetragonal ferrite into cubical ferrite proceeds simultaneously with the reduction process, and influences the peculiarities of the latter. There are 3 figures and 7 references, 3 of which are Soviet.

ASSOCIATION: Institut metallurgii Ural'skogo filiala Akademii nauk SSSR (Institute of Metallurgy of the Ural Branch of the Academy of Sciences, USSR)

SUBMITTED: June 22, 1959

Card 3/3

S/080/60/033/010/005/029
D216/D306

AUTHORS: Moskvicheva, A.G., and Chufarov, G.I.

TITLE: Reduction of iron oxide and magnetite by mixtures of hydrogen and carbon monoxide at low temperatures

PERIODICAL: Zhurnal prikladnoy khimii, v. 33, no. 10, 1960, 2212 - 2215

TEXT: Supplementary experimental work has been done on the reduction of iron oxides by mixtures of hydrogen and carbon monoxide at 275°C under pressures of 240 - 260 mm Hg. The gaseous products were collected in a receiver cooled with liquid nitrogen. The CO_2-water vapor mixture was analyzed by fractional distillation, the CO_2 distilling-off at -15° and the water at room temperature. The percentage reduction-time curves are given, showing that the higher the percentage of CO in the initial mixture the higher the reduction rate. The composition of the gaseous products of the reaction

Card 1/3

S/080/60/033/010/005/029
D216/D306

Reduction of iron oxide and ...

is given in tabulated form. Where the CO concentration in the initial gas is small to effect the reduction of Fe_2O_3 to Fe_3O_4, P_{CO}/P_{H_2}. When the concentration of CO is increased the ratio P_{CO_2}/P_{H_2O} becomes greater than P_{CO}/P_{H_2}. The effect of water vapor on the reduction rate is studied. There is a limiting water vapor concentration which retards the reaction $Fe_2O_3 \longrightarrow Fe_3O_4$, but it is suggested that a certain amount of water vapor is absorbed on the oxides. In the second stage of the process - the reduction of the Fe_3O_4 - the reducing capacity of hydrogen is higher than that of carbon monoxide in the low temperature region. The percentage reduction-time curves are given for magnetite -- prepared by oxidizing iron sponge. The lower reduction rate with higher CO concentrations is clearly indicated. Also the composition of initial gas mixtures and the resulting gaseous products are shown in tabulated form. The experimental work done confirms the theoretical kinetics of the reduc-

Card 2/3

tion of iron oxides by H_2/CO mixtures. Carbon monoxide shows greater activity for ferric oxide and hydrogen for magnetite. Comparatively small additions of CO to H_2 (5 - 20 %) are additive in their effect on the reduction of Fe_2O_3, but small additions of H_2 to CO retard the first stage of the process. There are 2 figures, 2 tables and 6 Soviet-bloc references.

SUBMITTED: January 25, 1960

S/076/60/034/012/007/027
B020/B067

AUTHORS: Zhuravleva, M. G., Bogoslovskiy, V. N., and Chufarov, G. I.

TITLE: Effect of Additions of Potassium and Sodium Carbonate on the Reduction of Oxides and Ferrites of Nickel and Cobalt by Graphite

PERIODICAL: Zhurnal fizicheskoy khimii, 1960, Vol. 34, No. 12, pp. 2704-2708

TEXT: Nickelous oxide was obtained by decomposing nickel nitrate at 1100°C on air while cobalt oxide was obtained by thermal dissociation of Co_3O_4 at 950° in nitrogen atmosphere. The corresponding ferrites were prepared by a 30-hour annealing of the oxides in a mixture with iron oxide at 1200°C. Acheson graphite which had been annealed at 1100° in vacuo was used as oxidzing agent. Sodium and potassium carbonate were taken in quantities of 1 wt% of the oxide or ferrite, and graphite was taken in a quantity which was three times higher than the amount necessary for the reduction to the metal. The weighed portion was 0.5g of the mixture.

Card 1/3

Effect of Additions of Potassium and Sodium Carbonate on the Reduction of Oxides and Ferrites of Nickel and Cobalt by Graphite

S/076/60/034/012/007/027
B020/B067

The reduction of nickelous oxide with graphite at 700°C is delayed as soon as a yield of 50% is attained. In the presence of 1% K_2CO_3 or Na_2CO_3 the reduction is accelerated and completed. The accelerating effect of potassium and sodium is almost the same. Cobaltous oxide is reduced at higher temperatures than nickelous oxide, and the kinetic curves have no maximum (Fig. 2). The addition of K_2CO_3 or Na_2CO_3 increases the reduction rate at 800° by many times. In this case the effect of K_2CO_3 is stronger than that of Na_2CO_3. Also the reduction of nickel ferrite is accelerated by adding the above-mentioned salts. In this case the initial reaction temperature is also reduced (Fig. 3). The accelerating effect of potassium carbonate is higher than that of sodium carbonate. Also the reduction of cobalt ferrite is considerably accelerated by adding the salts. The reduction of nickel ferrite without addition proceeds under the formation of metallic nickel whose lattice parameters gradually increase. During the reduction between 35 and 50% the lattice parameters of the solid solution Ni - Fe do not change. The results of the X-ray structural analysis of

Card 2/3

Effect of Additions of Potassium and Sodium Carbonate on the Reduction of Oxides and Ferrites of Nickel and Cobalt by Graphite

S/076/60/034/012/007/027
B020/B067

the reduction products of nickel ferrite show that the phase with spinel lattice, i.e., ferrite, is present in all reaction stages to almost 70%. The phase with NaCl lattice, which in this case corresponds to wüstite or the solid solution of Fe(Ni)O, was first observed in small quantities with a 51% reduction, while it predominates with a 71% reduction. The metallic phase which is formed in the reduction of nickel ferrite with additions is a solid solution of iron in nickel. The change of the lattice parameters of this phase is shown. The phase composition of the solid reduction products and the parameters of the metallic phase indicate that in the reduction of nickel ferrite with additions the number of the Fe-ions which pass into the metallic phase is higher than in the reduction without additions. There are 5 figures and 8 references: 7 Soviet and 1 US.

ASSOCIATION: Ural'skiy filial AN SSSR, In-t metallurgii (Ural Branch of the AS USSR, Institute of Metallurgy)

SUBMITTED: March 10, 1959

Card 3/3

81701

S/020/60/132/05/28/069
B011/B126

5.4110

AUTHORS: Zhuravleva, M. G., Chufarov, G. I., Corresponding Member AS USSR, Braynina, D. Z.

TITLE: Reduction of Manganese Ferrite by Hydrogen and Graphite

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 132, No. 5, pp. 1074 - 1077

TEXT: The authors carried out the above reduction by hydrogen in a closed apparatus with gas circulation. The reduction rate of ferrite rises as the reduction progresses and reaches a maximum at about 30-40% oxygen removal (Fig. 1). The reduction then slows down and comes practically to a halt after removal of 75% O_2. According to X-ray-structural analysis the sample contained metallic iron and manganous oxide. The use of graphite powder in a vacuum of about 10^{-2} mm caused the reduction rate to decrease with progressing process (Fig. 2). The kinetic curve shows a clear minimum at about 25% reduction. The reduction then accelerates a little, only to sink to nil towards the end of the process.

Card 1/3

81701
S/020/60/132/05/28/069
B011/B126

Reduction of Manganese Ferrite by Hydrogen and Graphite

Graphite completely reduces manganoferrite at 1,000°. The Spinell phase can only be proved for up to 20% reduction. Possible phases here are ferrous oxide, manganous oxide, their solid solutions. No metallic phase is detectable in this study. Above a 20% reduction there are two phases, the lower oxide and the metal phases. There are solid solutions of stable concentration here. According to the phase diagram of the Mn - Fe system (Ref. 6), the solid γ-solution is stable at 1,000°. X-ray pictures show a predominant quantity of the solid α-solution, which is formed by cooling the γ-solution. Admixtures of potassium- or sodium carbonates accelerate the reduction of manganoferrite (Fig. 2). A phase with a Spinell-like lattice, similar to that of the ferrite used, is present in an 18.93% reduced sample, but it cannot be proved at 28.9% reduction. A phase with an NaCl-like lattice (which corresponds to the sub-oxide phase of MnO), is present in all samples. Its lattice parameter increases with the percentage of the reduction and approaches the size of the MnO-lattice, without, however, reaching it (Fig. 3). On the basis of these data the authors give a reduction mechanism of manganese-ferrite: when the oxygen is removed, a surplus of metal ions is formed on the surface of the crystal lattice. They can either form a ferrite

4

Card 2/3

81701

Reduction of Manganese Ferrite by Hydrogen and Graphite

S/020/60/132/05/28/069
B011/B126

lattice or a metal phase. Which process predominates depends on the ratio of oxygen removal rate to the reaction diffusion. When hydrogen is used for the reduction, the oxygen removal rate is higher than that of the diffusion. When graphite is used for the reduction, both rates are commensurable. The admixtures of alkali metal salts accelerate the chemical interaction of both the reducing compound and of that which is to be reduced. This is related to the variation in the electron condition of the lattice, into which univalent ions penetrate (Ref. 9). There are 3 figures and 9 references: 4 Soviet, 4 American, and 1 German.

ASSOCIATION: Institut metallurgii Ural'skogo filiala Akademii nauk SSSR (Institute of Metallurgy of the Ural Branch of the Academy of Sciences, USSR)

SUBMITTED: March 14, 1960

Card 3/3

S/020/60/135/002/031/036
B016/B052

AUTHORS: Zhuravleva, M. G., Chufarov, G. I., Corresponding Member of the AS USSR, and ~~Khromykh, L. G.~~

TITLE: Influence of Carbonates of Alkali Metals and Alkaline Earths on the Reduction of Iron by Graphite

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 135, No. 2, pp. 385 - 388

TEXT: The authors studied the effect of lithium, cesium, rubidium, and strontium on the reduction kinetics of magnetite, wustite, and ferrous oxide at 990°C. They also carried out an X-ray structural analysis of the solid phase of magnetite during reduction and with a 1% addition of K_2CO_3. They applied the method of continuous weighing by means of a quartz spring. The graphite used was three times the quantity required for reduction. The above metals were added in the form of carbonates (1% of the oxide weight). The CO_2 content in the gas was continuously determined by freezing and subsequent evaporation. It is shown that

Influence of Carbonates of Alkali Metals and Alkaline Earths on the Reduction of Iron by Graphite

S/020/60/135/002/031/036
B016/B052

Rb and Cs salts accelerate the reduction of magnetite considerably. This effect is particularly strong at the beginning of the process. This is explained by the high volatility of Rb and Cs salts which, at 950-990°C, quickly disappear from the reaction zone, as was shown experimentally. $SrCO_3$ mainly accelerates the second stage of the process. The effect of Li_2CO_3 is low. Fig.2 illustrates the reduction of ferrous oxide by graphite with and without the addition of the four carbonates. In this case, the addition of lithium was also ineffective. $SrCO_3$, however, accelerated the process by a multiple. The character of kinetics remained unchanged. Cs_2CO_3, like K_2CO_3, accelerates the reduction already at the beginning. The process starts at maximum rate and slows down after a 40-50% reduction. Summing up: The accelerating effect of alkali metals on the reduction of iron oxides with graphite increases during the transition from light to heavy metals, and is due to the action of ions of monovalent metals on the electron state in the crystal lattice of iron oxide. The salts of divalent alkaline earths ($SrCO_3$) mainly

Card 2/3

Influence of Carbonates of Alkali Metals and Alkaline Earths on the Reduction of Iron by Graphite

S/020/60/135/002/031/036
B016/B052

accelerate the reduction of wustite to the metal. This is closely related to the redistribution of electron density in the imperfect structure of wustite. There are 4 figures and 3 Soviet references.

ASSOCIATION: Institut metallurgii Ural'skogo filiala Akademii nauk SSSR (Institute of Metallurgy of the Ural Branch of the Academy of Sciences USSR)

SUBMITTED: July 19, 1960

Card 3/3

ANTONOV, V.K.; CHUFAROV, G.I.

Reduction of manganous oxide with hard carbon. Trudy Inst. met. UFAN SSSR no.7:101-105 '61. (MIRA 16:6)
(Manganese oxides) (Carbon)

S/126/61/012/005/010/028
E111/E435

AUTHORS: Shabalina, O.K., Chufarov, G.I.

TITLE: Mechanism and kinetics of the decomposition of wüstite. I

PERIODICAL: Fizika metallov i metallovedeniye, v.12, no.5, 1961, 697-702

TEXT: Wüstite decomposition below 570°C is important in both scaling and iron-oxide reduction. The authors have therefore carried out an investigation in which special attention was paid to changes in the microstructure of the free wüstite surface during decomposition and to the kinetics of the process as a whole. The process takes place in two stages:

$$(1 - 4y)Fe_{1-x}O \rightarrow (1 - 4x)Fe_{1-y}O + (x - y)Fe_3O_1 \; ; \; x > y \; \ldots . \quad (1)$$

$$4Fe_{1-y}O \rightarrow Fe_3O_4 + (1 - 4y)Fe_\alpha \ldots . \quad (2)$$

Wüstite was prepared by oxidation of armco iron with a $CO-CO_2$ atmosphere (2:3) at 1040°C cooling to 800°C and quenching. The

Card 1/4

S/126/61/012/005/010/028
E111/E435

Mechanism and kinetics of ...

Wüstite scale was chipped off to give 4 x 10 x 0.3 mm coarsely crystalline plate specimens. These plates were vacuum annealed at 350°C for various periods. Decomposition was studied by qualitative X-ray structural phase analysis on the powdered scales in a high-resolution camera. The lattice parameter of wüstite and its decomposition products were determined. Magnetic analysis (Ref.10: Kifer, I.I. and Pantyushin, V.S., Testing of Ferromagnetic Materials.Gosenergoizdat, M.-L, 1955) was used for following the process quantitatively, the specific magnetization being determined with the aid of a standard nickel specimen. An electron microscope with a resolution of 100 Å was used to study decomposition on the free surface. The inner and outer faces of the scale were studied by X-ray structural analysis; rapid photography with focusing on the strongest structural lines of the phases was used for phase analysis; the parameter was determined by back reflection. $K_\alpha Co$ radiation was used in all the X-ray work. Powder X-ray patterns showed the initial specimens to be $Fe_{0.925}O$ but there were signs of the start of decomposition on the outer side of the scale. The lattice parameter there was 4.299 Å, that on the inside having the average value of 4.302 Å. A multi-

Card 2/4

step relief was found electron microscopically on the outer surface, that on the inside being typical of crystal cleavage. Observations on the decomposition at 350°C showed that within 15 minutes the process had spread to the inner face. At the outer face there was more metastable than original wüstite. With further decomposition, wüstite disappeared first from the outer and then the inner face; the hypoeutectoidal formation of magnetite was accompanied by the appearance of fairly dense formations at both the inner and outer faces. The course of the process is shown by Fig.4 (specific saturation magnetization σ_s as function of time (log scale) in hours): in about 1 to 1.5 hours the first-stage reaction (1) is completed. This enables σ_s to be checked by calculation, values of x and y being obtained from parameters of the original and metastable wüstite (Ref.3: Marion M.F. Doc. metallurg., no.24, 1955, 87) and using the tabulated σ_s value for magnetite. Satisfactory agreement was obtained. After 2 hours holding at 350°C, the second eutectoidal-decomposition stage of the process begins, iron being detected on the outer side of the scale and, after 5 hours, on the

Mechanism and kinetics of ...

S/126/61/012/005/010/028
E111/E435

inner side. On both sides, numerous pores about 0.1 micron in size appeared. This porosity is more pronounced than that in the first stage. Pore formation is due to coagulation of vacancies caused by diffusion of iron ions, which in the wüstite lattice occurs more rapidly than diffusion of oxygen ions. There are 7 figures and 13 references: 7 Soviet-bloc and 6 non-Soviet-bloc.

ASSOCIATION: Institut metallurgii UFAN (Institute of Metallurgy UFAN)

SUBMITTED: March 6, 1961

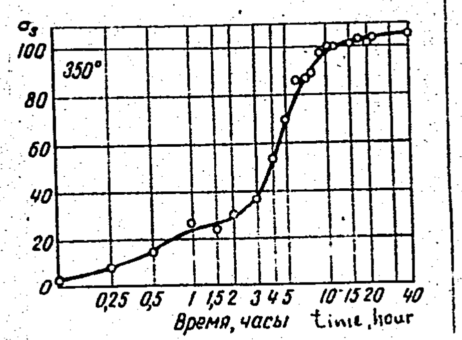

Fig.4.

Card 4/4